Subgrade Stabilization Using Geosynthetics

RESEARCH PROJECT TITLE
Central Iowa Expo Pavement Test Sections: Phase I – Foundation Construction (InTrans Project 12-433)

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The Iowa Department of Transportation (DOT) worked with its research partners to design comparative pavement foundation test sections at the Central Iowa Expo Site in Boone, Iowa. The project was constructed from May through July 2012. Sixteen 700 ft long test sections were constructed on 4.8 miles of roadway with the following goals:

- Construct a test area that will allow long-term performance monitoring
- Develop local experience with new stiffness measurement technologies to assist with near-term implementation
- Increase the range of stabilization technologies to be considered for future pavement foundation design to optimize the pavement system

This tech brief provides in situ test results and key findings from test sections constructed using four different geosynthetics for subgrade improvement on this project.

Background

Geosynthetics have been used in pavement foundation layers for separation, filtration, lateral drainage, and reinforcement purposes (Berg et al. 2000). The mechanisms by which geosynthetics provide reinforcement when placed at the subbase and subgrade interface include lateral restraint or confinement of subbase material, and increase in bearing capacity.

The benefits of four different geosynthetics—woven and non-woven (NW) geotextiles, and biaxial and triaxial polymer geogrids—are evaluated in this study.

Woven and non-woven geotextiles act primarily as separation layers between strata to prevent the upward migration of fine-grained particles from the subgrade into subbase layers. The non-woven can also provide lateral drainage. Polymer geogrids act primarily as reinforcement by providing lateral restraint or confinement of aggregate layers above subgrade.

Description of Test Sections and In Situ Testing

The original project conditions consisted of a thin chip seal coat and 6 in. granular subbase at the surface. The granular subbase material was excavated down to the subgrade (Figure 1). The subgrade material is classified as CL or A-6(5). The geosynthetics were placed on the subgrade and a nominal 6 in. crushed limestone modified subbase layer was placed over the geosynthetics. The subbase layer is classified as GP-GM or A-1-a (7% fines content).

Figure 1. Excavated subgrade on 4th St. North test section

The 4th St. North and South segments included NW and woven geotextiles, respectively. The woven geotextile material is shown in Figure 2. According to the manufacturer's product sheet, the woven geosynthetic material has an aperture opening size of #30 US sieve, a grab tensile strength of 350 lb, and a water flow rate of 40 gpm/ft^2. The NW geotextile material is made of a polypropylene, staple fiber, needle-punched material (Figure 3). According to the manufacturer product sheet, the NW geotextile has an aperture opening size of #70 US sieve, a grab tensile strength of 160 lb, and a water flow rate of 110 pm/ft^2.

Triaxial and biaxial geogrids made of polypropylene sheets were used on the 5th St. North and South segments, respectively, at the interface of subgrade and limestone subbase layers. The triaxial geogrid (Figure 4) has a triangular aperture shape and a radial stiffness of 15,075 lb/ft at 0.5 percent strain. The biaxial geogrid (Figure 5) has a rectangular aperture shape and an ultimate tensile strength of 880 lb/ft.

All of the geosynthetics were installed by unrolling the rolls longitudinally along the test section. Two rolls were overlapped by at least 1 ft covering the entire subgrade width and were staked down with 5 in. staples. After the subbase layer was placed, it was graded to the desired elevation using a motor grader, and then compacted using a vibratory smooth drum roller.

In situ testing included testing the subgrade prior to placement of the geogrid (July 2012), and the subbase layer shortly after placement (July 2012), three months after placement (October 2012), in frozen state (February 2013), and during spring-thaw (April and May 2013).

In situ testing methods used included light weight deflectometer (LWD), dynamic cone penetrometer (DCP), falling weight deflectometer (FWD), and roller-integrated compaction monitoring (RICM). Only results from DCP test results are presented in this tech brief. The remaining test results are presented in the Phase I final report.

In Situ Test Results and Key Findings

DCP-CBR profiles and cumulative blows with depth profiles (from one selected test location) from the four test sections, three months after construction (October 2012) and during spring thaw (April 2013), are shown in Figures 6 through 9. CBR values in the subbase and subgrade (top 12 in.) layers for October 2012 and April 2013 testing are reported on the figures. Average CBR of subbase layer based on three measurements from each test section from October 2012 and April 2013 testing are shown in Figure 10.

Figure 2. Woven geosynthetic placed at the interface of subgrade and limestone subbase layers on 4th St. South test section

Figure 3. Non-woven geosynthetic placed at the interface of subgrade and limestone subbase layers on 4th St. North test section

Figure 4. Triaxial geogrid placed at the interface of subgrade and limestone subbase layers on 5th St. North test section

Figure 5. Biaxial geogrid placed at the interface of subgrade and limestone subbase layers on 5th St. South test section

The average CBR of the subbase layers in the woven/NW geotextile sections were lower than in the triaxial/biaxial geogrid sections. During October 2012 testing, the triaxial geogrid section showed the highest average CBR (234) and the woven geotextile (89) showed the lowest average CBR in the subbase layer. During April 2013 testing (spring-thaw), the average subbase CBR values in the test sections were lower compared to October 2012 testing and varied from about 33 to 46.

References

Berg, R. R., B. R. Christopher, and S. Perkins. 2000. "Geosynthetic reinforcement of aggregate base/subbase courses of pavement structures – GMA White Paper II." Prepared for AASHTO Committee 4E by the Geosynthetic Materials Association, Roseville, MN, June 2000.

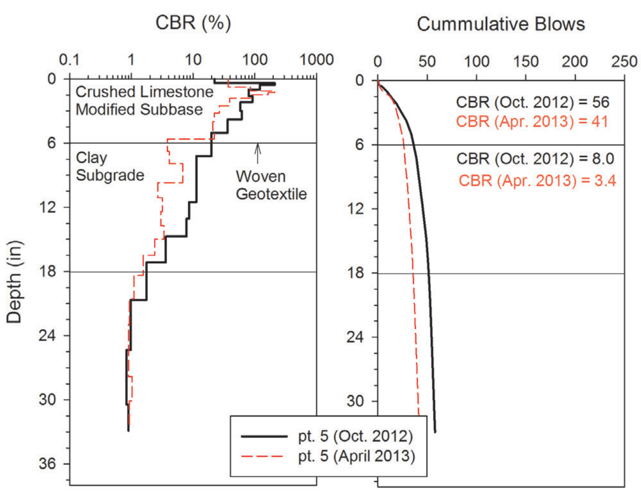

Figure 6. DCP-CBR and cumulative DCP blows with depth profiles for 4th St. South woven geotextile-reinforced section

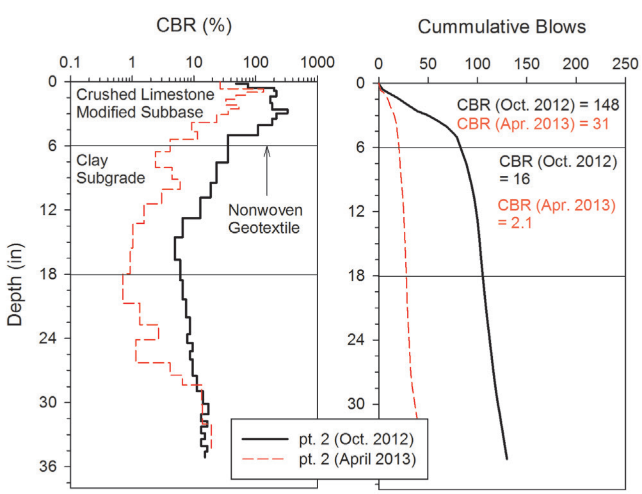

Figure 7. DCP-CBR and cumulative DCP blows with depth profiles for 4th St. North non-woven geotextile-reinforced section

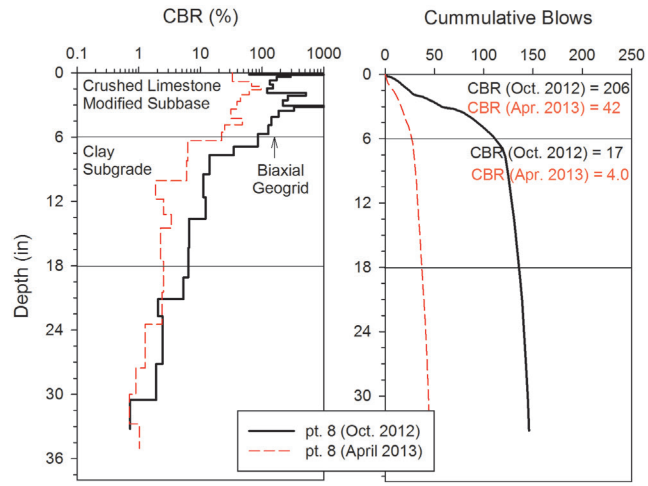

Figure 8. DCP-CBR and cumulative DCP blows with depth profiles for 5th St. South biaxial geogrid-reinforced section

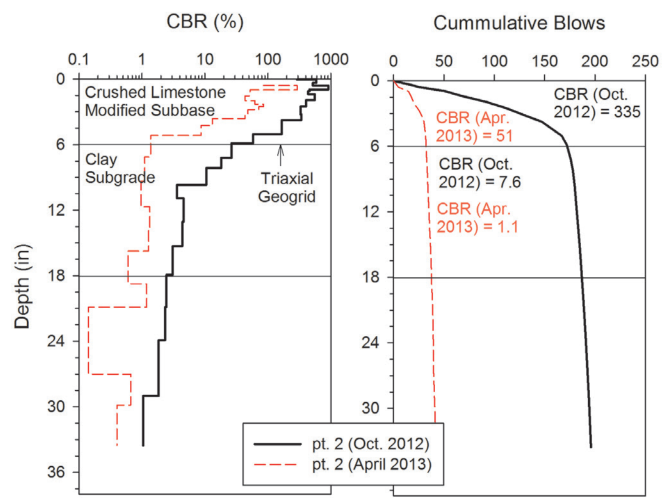

Figure 9. DCP-CBR and cumulative DCP blows with depth profiles for 5th St. North triaxial geogrid-reinforced section

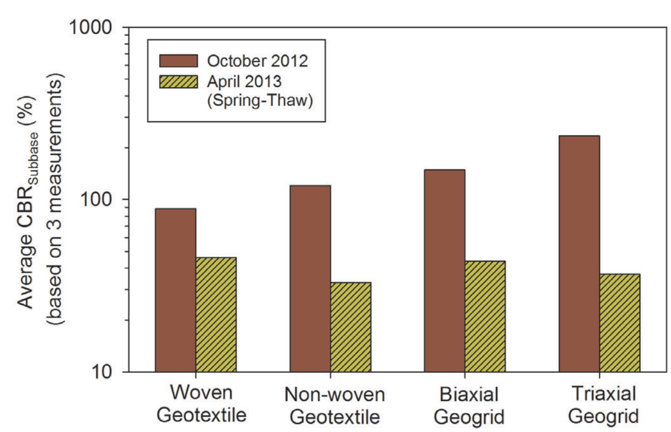

Figure 10. Average DCP-CBR of modified subbase layer (based on three measurements per test section) from different geosynthetic reinforced sections